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Attentional biases for food stimuli in external eaters:
Possible mechanism for stress-induced eating?

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Abstract

External eaters reportedly increase snack intake when stressed, which could be due to an attentional shift towards food stimuli. Attentional biases for food stimuli were tested in high and low external eaters in stress and control conditions, using a computerised Stroop. A significant interaction was observed between external eating group and condition for snack word bias. This suggested that low external eaters have a greater bias for snack words when unstressed and that stressed, high external eaters have a greater bias for snack words than stressed, low external eaters, which could contribute to stress-induced snack intake in high external eaters.

Introduction

Laboratory and field studies have shown that exposure to stress is associated with changes in food intake (e.g. Newman, O'Connor, & Conner, 2007; O'Connor, Jones, Conner, McMillan & Ferguson, 2008; Oliver, Wardle, & Gibson, 2000). Eating style is an established moderator of stress-induced eating (Greeno & Wing, 1994), with numerous reports that restrained and emotional eaters are more susceptible to increased intake (e.g. O'Connor & O'Connor, 2004, Oliver et al., 2000). In contrast, the moderating role of external eating (eating in response to environmental cues rather than internal hunger state; Schachter, Goldman, & Gordon, 1968), has been relatively neglected. However, one study examining the roles of restrained, emotional and external eating styles reported that external eating style was the most important moderator of the relationship between daily hassles and snack intake, such that emotional and restrained eating were non significant moderators (Conner, Fitter, & Fletcher, 1999).

One possible explanation for stress-induced eating in external eaters is a change in attention towards environmental cues during stress. Heatherton and Baumeister (1991) argued that stress causes individuals to increase awareness of the immediate environment and decrease awareness of the self. In support of this, ego threatening stressors, which induce a strong sense of self-awareness, are reportedly more successful at increasing food intake than other stressor types (e.g. Heatherton, Herman, & Polivy, 1991). Since external eaters are driven to eat by environmental cues, an attentional shift towards the immediate environment might be expected to increase food intake in these individuals.

To date, only one study has investigated attentional biases for food stimuli in external eaters (Johansson, Ghaderi, & Andersson, 2004). Interestingly, the results suggested that high external eaters showed a bias away from, rather than towards, food words in a dot probe task. However, this study did not manipulate or measure participants' stress levels. Since high external eaters have been found to increase snack intake during periods of stress (Conner et al., 1999) an attentional bias towards food stimuli may emerge when stressed rather than under normal conditions, though this has yet to be tested. Therefore the present study aimed to test whether external eaters show an attentional bias towards food stimuli, particularly snack food stimuli, when stressed.

Methods

Participants

Participants were contacted from 315 students who had completed the Dutch Eating Behavior Questionnaire (DEBQ; Van Strien, Frijters, Bergers, & Defares, 1986) and scored within the top or bottom twenty per cent on the external eating subscale (scores <2.7 and >3.7 for low and high external eating scores respectively). Sixty nine took part; however two participants were removed due to outlying bias scores and one participant was removed because the microphone had not detected many responses, leaving a total of 66 participants. Of these, 36 were high external eaters and 30 low external eaters. There were 33 participants in both the stress and control conditions, with equal numbers of males and females (13 males and 20 females) in each. Ages ranged from 18 to 59 years with a mean of 21.60 years, all participants spoke English as a first language. Participants were offered five pounds

and the chance to win fifty pounds in a prize draw. The research was approved by the Institute's Ethics Committee.

Measures

State anxiety was measured using the shortened version of the Spielberger State-Trait Anxiety Inventory (STAI; Marteau & Bekker, 1992), where six items are rated from 1 to 4 and summed to give a score between 6 and 24. Participants rated their hunger before the experiment using a seven-point anchored scale from 'not at all hungry' to 'extremely hungry'. Body mass index (BMI), emotional and restrained eating were measured using self-reported height and weight and the DEBQ.

Materials

There were 100 words in the Stroop task (Stroop, 1935), in three main categories: neutral (25 words; e.g. jersey, batteries), ego threatening (25 words; e.g. lonely, worthless)¹, and food (50 words; e.g. cheese, pineapple). Words were matched between categories for length and frequency using Thorndike and Logue (1944) and Leech, Rayson, and Wilson (2001). Food words were subcategorised into snack and meal words by eight independent raters, who identified foods consumed as snacks, meals and both. These ratings provided fifteen snack words (e.g. grapes, chocolate), twenty-three meal words (e.g. sausages, cauliflower), and twelve snack or meal foods (e.g. bread, pancakes), with all categories represented by healthy and unhealthy foods.

Modified Stroop task

A modified Stroop task was chosen to test attentional biases towards food stimuli to provide consistency with previous studies (Faunce, 2002). This was computerised to reduce experimenter expectancy effects (Davidson & Wright, 2002). Words were presented individually in one of four colours (red, green, yellow or blue)

on a black background on a computer screen sized 8 by 11 inches. The participant was required to say aloud the colour of the word into a connected microphone, with response times recorded by the computer (cf., Smith & Waterman, 2005). The words appeared once each, in randomised order and colours, with a 1000ms pause between words. The experimenter coded each response as correct, incorrect or invalid (e.g. not detected by the microphone) using the keyboard (cf., Smith & Waterman, 2005).

There were four practice trials to enable familiarisation with the task.

Procedure

Participants were tested individually in the laboratory. Each participant was given an information sheet outlining the study procedure before providing written consent to take part. The information was identical between conditions, except that controls were informed that they would perform a pen and paper task, and the experimental group informed that they would be asked to prepare a presentation. The participants then completed the hunger and state anxiety scales. Those participants in the stress condition were given a written list of nine controversial topics (e.g. 'abortion', 'cannabis legalisation') and instructed that they would be given ten minutes to prepare a four-minute speech about their opinion towards one topic of their choice, which would be video-recorded and performed live to a group of psychologists watching through a two-way mirror. This was based on the procedure of Oliver et al. (2000), and designed to induce anticipatory stress to an ego-threatening stressor. Participants in the control condition were asked to circle every 't' in a short piece of text for ten minutes. State anxiety was measured again immediately after the stress or control tasks. Both groups then completed the Stroop test. Following this, participants in the stress condition were informed that they

would not be asked to perform the presentation and all participants were paid and debriefed.

Statistical analysis

T-tests were used to test the effect of the stress manipulation on state anxiety. Incorrect responses (3%) and outliers in response times on the Stroop task were excluded from analysis, following the procedure of Mogg et al. (2000). Outliers were identified using box and whisker plots and response times below 300ms and above 900ms (5%) were removed. Bias scores in the Stroop task were calculated for all 50 food words, snack and meal food words by subtracting the mean response time for neutral words from the mean response time for target words, so that positive scores indicated greater latencies for target words. Box and whisker plots were used to identify cases with outlying bias scores. Interaction effects between external eating and stress for bias scores were tested using ANCOVA with emotional eating as a covariate².

Results

Stress manipulation

There was no significant difference in anxiety between stress and control groups pre manipulation, $t(64) = 1.76$, *ns* but a significant difference post manipulation, $t(64) = 6.46$, $p < .001$. There was no significant difference in pre and post manipulation anxiety in the control group $t(32) = -1.64$, *ns* but anxiety scores were significantly greater post than pre manipulation within the stress group, $t(32) = -7.25$, $p < .001$.

Bias for food words

<Table 1>

High and low external eaters in both conditions had positive mean bias scores for food words, however low external eaters in the control condition had the greatest

mean bias (Table 1). ANCOVA with food bias score as the dependent variable, stress condition and external eating as independent variables and emotional eating as a covariate revealed a marginally significant interaction between external eating and stress, $F(1, 60) = 3.36$, $p = .07$ and a marginally significant effect of stress on bias for food words, $F(1, 60) = 3.83$, $p = .06$. These effects are likely due to the large difference in bias scores between high and low external eaters within the control condition and a greater bias for food words in the control condition than in the stress condition. There was no main effect of external eating group, $F(1, 60) = .17$, *ns*.

Bias for meal food words

Table 1 shows that low external eaters in the control condition had the greatest mean bias. ANCOVA revealed no significant interaction between external eating group and stress condition, $F(1, 60) = 0.93$, *ns* and no significant effect of external eating, $F(1, 60) = 1.42$, *ns*, for meal food words, but a significant main effect of stress condition, $F(1, 60) = 7.09$, $p < .05$, where there was a greater bias for meal food words in the control condition than in the stress condition.

Bias for snack food words

Bias scores for snack words were positive in all conditions except for low external eaters in the stress condition, after controlling for emotional eating. ANCOVA revealed no main effects of external eating, $F(1, 60) = .14$, *ns*, or stress condition, $F(1, 60) = .30$, *ns*, but a significant interaction between external eating and stress for the snack word bias scores, $F(1, 60) = 4.49$, $p < .05$. Post-hoc ANCOVAs revealed there was no difference in scores between high and low external eaters in the control condition, $F(1, 29) = 1.50$, *ns*, but there was a marginal difference between high and low external eaters in the stress condition, $F(1, 30) = 3.24$, $p = .08$, where high external eaters showed a greater bias. There was no difference between high external

eaters between stress and control conditions, $F(1,32) = 1.25$, *ns*, but a marginal difference in the low external eaters between the two conditions, $F(1,27) = 3.47$, $p=.07$, where bias scores were greater in the control condition.

Discussion

There was little evidence that high external eaters in the stress condition showed greater attentional biases for *all* food words. High and low external eaters showed positive bias scores for food words, with the greatest bias scores in the low external eaters in the control condition. Positive bias scores are usually interpreted in the literature as indicating a bias towards target words, but it is difficult to explain why low external eaters should show a bias towards food words, especially in light of a previous finding that tasting an appetiser prior to the Stroop task is required to observe any interference in normal eaters (Overduin, Jansen & Louwerse, 2006). One possibility is that low external eaters have no reason to avoid food-related stimuli under normal conditions since they are less susceptible than high external eaters to increased food intake in response to such cues.

The prediction that bias scores in external eaters would be more prominent for *snack* food words was partially supported, as a significant interaction was observed between external eating and stress for these words. Further exploration of the interaction showed two marginal effects: high external eaters tended to have a greater bias in the stress condition than did low external eaters, and low external eaters tended to have a greater bias in the control condition than the stress condition. That a difference between high and low external eaters only started to emerge in the stress condition may indicate a difference in processing of snack-related information between high and low external eaters only under conditions of stress, and appears consistent with the finding that high external eaters increase snack food intake when

stressed (Conner et al., 1999). As yet the construct of external eating and its relationship to stress-induced eating has not been validated or greatly researched. It might be speculated that the greatest bias scores for snack foods would appear only in high external eaters who are also high emotional eaters and may be especially prone to stress-induced eating, a possibility that future studies could test.

Interestingly, a significant main effect of stress emerged for bias towards meal food words, such that attentional biases towards this type of food word were attenuated within the stress condition. This could indicate a decreased interest in meal foods when stressed, which would be consistent with the finding that the intake of snack foods rather than meal foods increases with stress (O'Connor et al., 2008) and the notion that snacks are easier to digest when in an aroused physiological state (Oliver et al., 2000).

The present study employed a Stroop task to measure attentional biases, which is consistent with most previous studies of attentional biases for food (Faunce, 2002). However, this paradigm has been criticised because greater response latencies could also indicate avoidance of target stimuli. The dot probe attentional task aims to counteract this problem by presenting neutral and target stimuli simultaneously, though has been criticised for its vulnerability to strategic processing of stimuli by participants (e.g. Broschott, de Ruiter, & Kindt, 1999). Furthermore, studies using the dot probe have reported no difference in bias scores between restrained and unrestrained eaters, yet subsequent recognition tasks indicate that restrained eaters had attended to food words (Boon, Vogelzang, & Jansen, 2000). Nevertheless, the findings of the current study would be strengthened by replication with the dot probe paradigm.

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1. Ego threatening words were included to test whether a positive bias for food stimuli in external eaters would be accompanied by a negative bias for threat stimuli (c.f. Heatherton & Baumeister, 1991). However the results from the analysis of ego threatening words are not reported here.
2. High and low external eaters differed in emotional eating where high external eaters showed greater scores, $t(63) = 6.71$, $p < .001$. There were no group differences in hunger or restrained eating style.

Table 1. Mean bias scores (ms), eating style, hunger and BMI for high and low external eaters in stress and control conditions (N=66)

	Lo external control (N=14)		Lo external stress (N=16)		Hi external control (N=19)		Hi external stress (N=17)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
All foods*	20.2	5.6	1.6	5.5	8.5	4.9	8.0	5.3
Meal foods*	27.3	6.8	5.6	6.7	12.2	6.0	2.1	6.4
Snack foods*	14.6	8.6	-4.6	8.5	2.8	7.6	14.8	8.1
Hunger	3.1	0.5	3.4	0.4	3.2	0.4	3.5	0.4
External eating	2.4	0.1	2.4	0.1	4.0	0.1	4.0	0.1
Emotional eating	2.1	0.2	2.0	0.1	3.0	0.2	3.2	0.1
Restraint	2.1	0.3	2.0	0.2	2.3	0.2	2.2	0.2
BMI	21.5	0.7	22.2	0.5	22.7	0.8	21.8	0.6

* Means shown are estimated marginal means after controlling for emotional eating